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DESMIDS AND DIATOMS.

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It is the purpose of the present article to present in a familiar way the more important features in the structure and history of some organisms in general but little known, the Desmidiaceæ and Diatomaceæ, and to suggest a few reflections upon their habits and economical value, but more especially their importance, both in past ages and at the present time, in modifying the physical features of the globe.

Without entering into the facts of the discovery and history of these microscopic Algæ, it may be sufficient to say that they were originally included, together with two other very interesting groups, the Polygastrica or Many-stomached animals, and the Rotatoria or Wheel-animalcules, by the Prussian naturalist, Ehrenberg, under the common name of Infusoria. It is much to be regretted that a systematic classification, embracing numerous sub-families, genera and species, should thus have been introduced into scientific nomenclature, at a period when so little was really known of the true position of these organ-

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former, and containing within its cavity the "endochrome," or green coloring matter, which seems to be analogous to the chlorophyl or leaf-green of the higher plants; and, lastly, a thin hyaline membrane enclosing the two former, and analogous to a similar membrane among the Diatomaceæ. The surface of the cell thus enclosed is often ornamented by the existence of numerous markings, striæ, lines or dots, but still oftener by the presence of projecting points or spines, which give to many of the genera a singularly beautiful appearance. In the interior of this cell may sometimes be seen a curious movement of the cell contents, which has given rise to much discussion among the students of these forms. Some assign the circulation thus witnessed to ciliary action, others to the spontaneous movement of enclosed zoöspores; but as this is still a debated point, I shall not at present dwell upon it. The same is true of the motion quite commonly observed of the whole Desmid through the medium in which it lives, with a slow majestic movement, very suggestive of animality, and which caused these organisms to be assigned by the earlier writers to that kingdom. The existence of external "cilia," either in these or in the Diatomaceæ is exceedingly improbable. Like other plants, they have a marked tendency to travel towards the light, and have sufficient power of locomotion to penetrate to the surface of mud in which they have been imbedded during the drying up of pools.

The multiplication of the Desmids is accomplished by two methods: by self-fission, or the dividing of the cell-contents into two portions, as is commonly the case with all Algæ; or, secondly, by a true generative process, and the formation of "Sporangia." As, however, these processes are very similar to those which characterize the

reproduction of the Diatomaceæ, and as it is chiefly of the latter that this article is designed to treat, it is unnecessary to enter into a more minute description.

Before dismissing the subject of the Desmidiaceæ, I may say that they are exceedingly common, especially in open tracts, abounding in exposed localities. They are exceedingly beautiful, and, with the Diatoms, which are always associated with them, form objects well worthy of search on the part of those provided with the proper instruments to discern their beauties. They are very tenacious of life, I having frequently found them still green and healthy in bottles of water from which all other varieties of vegetable life had long since disappeared. As agents in the mechanism of Nature, the Desmids play an important part, not only by directly serving as the food of many aquatic animals, but also by their furnishing, in company with other plants, the oxygen which is so necessary for the purity of the water in which these animals are to dwell.

Lastly, the Desmids have a peculiar interest from the fact, that, notwithstanding their being destitute of the hard parts which constitute the fossil remains of other plants and animals, they are yet found in considerable numbers in the fresh-water marls of North America, and bodies bearing a striking resemblance to their Sporangia occur abundantly in the silicious nodules of the chalk, and even in the flinty hornstone of the Silurian and Devonian eras.* To this fact allusion will again be made in the discussion of the geological relations of the Diatomaceæ.

*It is generally stated that these organisms, termed Xanthidia, are the sporangia of Desmids; but if so, how is it that they occur in marine deposits, such as the chalk and hornstone, while the recent Desmids are exclusively fresh-water forms? In allusions to these fossils this fact seems to have been generally overlooked.

The close analogy existing between the structure and mode of growth of the Desmidiaceæ and that of other undoubted unicellular Algæ became evident with the rapid improvements in the instruments of observation. Not so, however, with the Diatomaceæ, for although the opinion is now almost universal among those most competent to decide the question, that they are truly vegetables, this conclusion was long opposed by able writers, and even now is by some authorities strenuously disputed. With the majority of observers I will assume their vegetable nature, and endeavor to describe the most important features in their structure and mode of growth.

The Diatoms (from *dia* and *temno*, to cut in two) are, like the Desmids, unicellular Algæ, consisting essentially of two plates, concavo-convex, bacillar, hemispherical or depressed, connected together by a band or hoop called the "connecting membrane," applied to and coinciding with the circumference of the valves, and enclosing within a coloring matter, which, unlike that of the Desmids and most true plants, is of a yellowish or orange-brown color. The form, structure, and marking of these valves are often very complex as well as beautiful, and are of vast importance in the classification of these organisms. As to *form*, the Diatoms present an infinite variety of size and outline. Mathematical curves of the most exquisite perfection, combinations which the designer would grasp with eagerness in the planning of his models, surfaces adorned with the most unlimited profusion of style and ornamentation, are everywhere presented. They may conveniently be arranged under two great heads; first, of the forms more or less linear or bacillar in outline, including most fresh-water species; and, secondly, those which are discoid, almost solely marine. This division is

not an accurate one, many linear forms being marine, and a few discoids fresh water, but the distinction is a convenient one, and sufficiently characteristic to apply to the majority of cases.

Among the forms whose general outline is linear, we have those which are straight and free (such as *Nitschia*, Pl. 13, fig. 8), those whose "frustules," as the separate individuals are termed, are adherent by the base, and which produce fan-like clusters, or even star-shaped aggregations (as in *Synedra*, fig. 33; *Asterionella*, fig. 17; and *Licmophora*, fig. 20); those with the individuals adherent by the sides, and producing lengthened filaments (fig. 18), which if one end of the cell be smaller than the other, will give rise to spirals (as in *Meridion*, fig. 12), or again lying free with others of its kind in a sort of gelatinous envelope or cushion (as in *Mastogloia*, fig. 19, *Encyonema*, etc.), or adhering by alternate corners and producing zigzag chains (as in *Diatoma*, fig. 16; *Grammatophora*, fig. 30; *Tabellaria*, fig. 13); or, lastly, not included in either of the above divisions, but still having a certain general resemblance to the typical straight line (as *Cocconema*, *Gomphonema*, etc.). These are by no means natural or scientific divisions, but aid in fixing in the memory their characteristic shapes. Between each other and the second great class of circular or discoid forms, there is every variety of gradation, the one insensibly passing into the other. The latter, or discoid forms, which, as I have said, are mostly but not exclusively marine, are also characterized by even greater variety of form and outline, often exceeding in beauty of conception and in delicacy of execution the most elaborate works of human ingenuity. As a general rule the surface of their valves is more or less broken into numerous dots, depres-

sions, or elevations, and frequent areolations, circular or hexagonal. This is a very general character of all the Diatomaceæ, and is due to the deposition of layers of silex variously disposed within or between the different membranes which enclose the cell, and which, remaining persistent and retaining all their delicate sculpturing after the removal of the organic contents, are the portions which become fossil and which, even in recent gatherings, are the chief features used for the discrimination of the species. Frequently several different modes of ornamentation are visible upon the same shell, and are possibly situated in its different layers. The exact position, and the number of such membranes, and the nature of the markings, are still subjects of discussion among the students of these forms. The presence of this silex, however, is the fact of most interest in their structure, whether they be regarded in a strictly scientific, or in an economical point of view.

Among the discoid forms may be enumerated those with a circular outline, and circular or hexagonal areolations (such as *Coscinodiscus*, Pl. 13, fig. 34; *Craspedodiscus*, etc.), those with a circular valve divided into partitions by radiating lines (as *Arachnodiscus*, fig. 29), those with a simple disk, but united into continuous filaments (as *Podosira*, fig. 25; *Melosira*, etc.), those with a more or less circular outline, but with the surface projecting into spines or processes which seem to connect adherent frustules (as in *Biddulphia*, fig. 31; *Eupodiscus*, etc.); or, lastly, of forms not truly circular in outline, but really modifications of the circle, and approaching that shape by insensible gradations (as *Triceratium*, fig. 27; *Amphitetras*, fig. 36; *Campylodiscus*, *Surirella*, etc.). As a rule, the circular forms may be compared to

tolerably flat thin pill boxes, or, still better, to a common watch. One genus, indeed, the *Hyalodiscus*, when magnified over 2,500 diameters, bears a striking resemblance to the covers of an engine-turned watch, two sets of delicate dots radiating in eccentric curved lines from the centre towards the periphery, and giving to the shell, under bright illumination, a truly exquisite appearance. Some have the disks so convex as to make a nearly spherical figure, others have the surface depressed at the centre, while others again are beset around the margin with a glittering row of spear-like points. The imagination can scarcely picture a form of beauty which does not find a counterpart among these most wonderful of Nature's medallions.

The multiplication of the Diatoms, like that of the Desmids and other unicellular Algæ, takes place according to one or the other of two modes, either by simple cell-multiplication, the original frustule dividing into two which again subdivide, or else by a true generative process, and the formation of Sporangia. The first method is exceedingly common, so much so, indeed, that we can scarcely find a specimen in which the process is not just ended, or in some stage of advancement. This multiplication takes place by the gradual enlargement or widening of the "connecting membrane" before alluded to. (See Pl. 13, figs. 31 *a*, and 23 *a*.) Nearly at the beginning of this process the contents of the cell are divided into two portions, while the lining or inner membrane of the parent cell becomes doubled inwards in an annular ring about the whole circumference along the line of division. This infolding membrane continues to advance, until a nearly complete division has taken place of the old cell into two new ones, the two new contiguous

valves becoming impregnated with silex before they have become free of the connecting membrane. (Pl. 13, fig. 31 *a*.) In this way a complete septum is formed, the two new frustules often remaining enclosed within the connecting membrane, like the inner tubes in a telescope. These new cells, which in every way are the exact counterpart in size and structure of their parents, may remain thus enclosed, but more frequently are left free by the falling off of the connecting membrane. The new frustules thus formed, by the greater or less adhesion among themselves, which differs in different species, give rise to all the different forms of aggregation already alluded to. If adherent side by side, the effect is to produce a lengthened filament, either straight (Pl. 13, fig. 18), or spiral (fig. 12); if adherent only at corresponding corners, a star-shaped figure is produced (fig. 17); if at alternate corners, a zigzag chain (fig. 16). Frequently processes of greater or less size are developed at the corners, which serve as means of adhesion between the two (fig. 23). Lastly, the division may be complete, and the resulting cells remain aggregated in a spongy mass (fig. 19); or else, entirely free, swim slowly through the medium in which they live (figs. 9, 10, 28, 32, etc.).

Of the contents of the cells or "frustules," their chemical composition, changes, and internal movements, it is unnecessary now to speak. Suffice it to say, that the existence of the so-called *stomachs*, organs of locomotion, etc., which Ehrenberg asserted that he had detected in their interior, have been entirely disproved by the researches of later authors. The "endochrome," as I have already said, is of a different color from that of most plants, and is even supposed by many to be of a different chemical composition; but in most other respects their

resemblance to true plants is very marked, and as they bear the closest analogy to the Desmids, which all observers now admit to be vegetables, it can scarcely be doubted that they, too, are of the same nature.

One of the greatest obstacles to a belief in the vegetable nature of the Diatoms has always been the wonderfully curious motions which nearly all of them exhibit in their living state. This is not a merely mechanical motion, due to light or other external agents, although they share this property with other known plants, but they seem to have a certain internal principle of locomotion peculiar to themselves. They may constantly be seen swimming through the water, with a motion slow, to be sure, when we consider how much that motion is magnified, yet certainly as rapid as that of many undoubted animals among which they dwell. As a general rule these motions are simply backwards and forwards, any interposing obstacle being pushed aside, but not avoided; at other times, the motion is a slow rolling from side to side. In one species, however (the *Bacillaria paradoxa*, (Pl. 13, fig. 18), so singular are the movements exhibited, and so unlike anything that occurs either in the animal or vegetable kingdom, that they never fail to excite astonishment in those who, for the first time, behold the curious phenomenon.

Like a lengthened ribbon, crossed by numerous close and parallel bands or bars, the Bacillaria frequently attains a length of an inch or more. Hanging from some green confervoid plant, or floating freely in the water, this fragile form, transparent and lustrous as the finest spun glass, is at first quite motionless. Slowly detaching itself, however, at one end, a strange activity will soon become apparent throughout its entire length. Each

glassy bar takes upon itself an individuality, and though still connected with the rest, moves as with an impulse of its own. The middle bar alone is motionless. Those on either side slide gently on the last, the one to the right, the other to the left, with clock-like regularity. The movement of the first is the signal for all the rest. Each in turn slips quickly along his neighbor's side, until from a long and ribbon-like band, we now have a series of glassy steps, each crystal bar resting slightly upon that below it. But the change is transient. When the whole series has thus unfolded, as it were, it begins to slowly recoil again. Each plant or bar resumes its former place, and the ribbon-like band again hangs motionless from leaf to leaf.

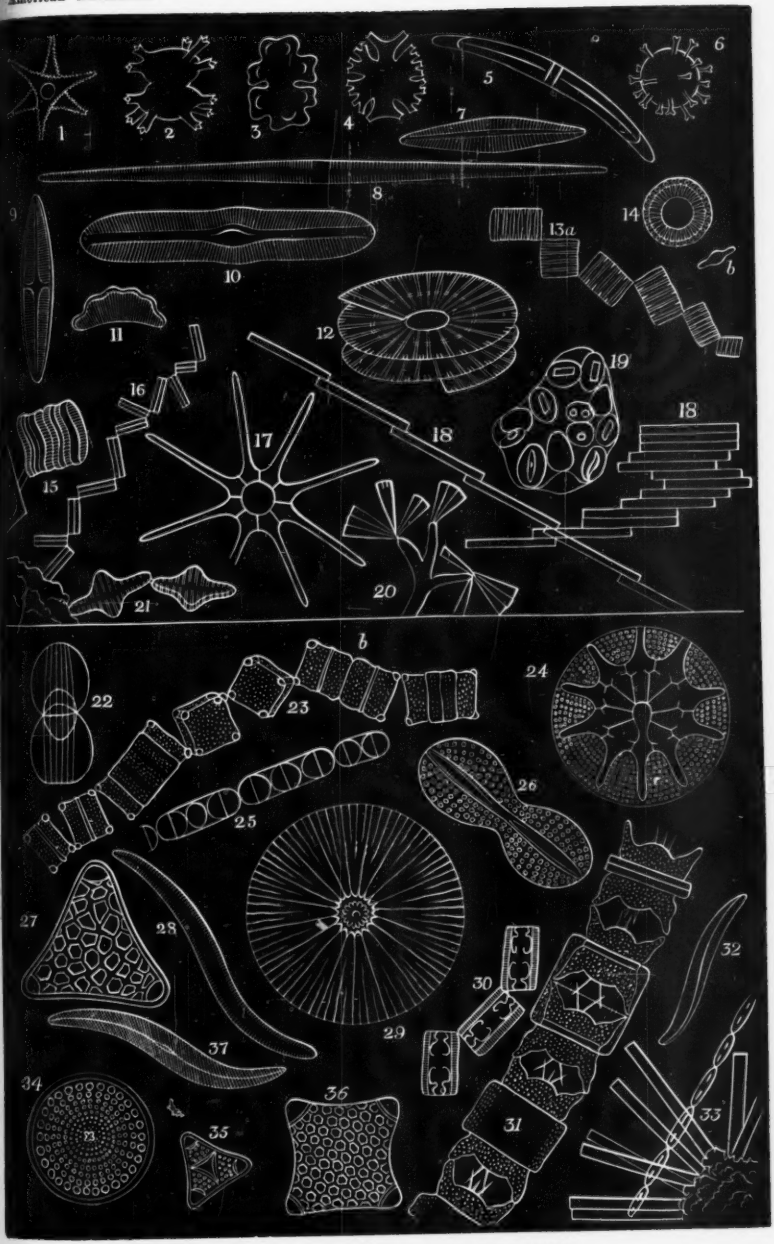
The cause of these motions has been severally assigned to the action of minute vibratory cilia, to an undulatory motion of the outer membrane, and to the mechanical effects resulting from the absorption or discharge of water. The subject, however, is one which yet remains in great obscurity. — *To be concluded.*

EXPLANATION OF PLATE 13.

Figs. 1-5. DESMIDS, — 1 and 3, Euastrum; 2 and 6, Xanthidium, resembling fossils found in flint; 4, Micrasterias; 5, Closterium.

Figs. 7-21. DIATOMS, — *Fresh-water.* 7, Navicula; 8, Nitschia; 9, Stauroneis; 10, Pinnularia; 11, Eunotia triodon; 12, Meridion vernale; 13, Tabellaria flocculosa, — *a*, front view, *b*, side view; 14, Cyclotella Kützingiana, — *b*, side view; 15, Achnanthes; 16, Diatoma flocculosum; 17, Asterionella; 18, Bacillaria paradoxa; 19, Mastogloia; 20, Licmophora; 21, Odontidium.

Figs. 22-36. DIATOMS, — *Marine Forms.* 22, Amphiprora; 23, Amphitetras, forming a zigzag chain, — *a*, a frustule about to divide into two, *b*, two frustules newly formed but not yet separated, the "connecting membrane" having fallen off; 24, Asteromphalus, a beautiful deep-sea form, taken from below 2,000 fathoms in the sea of Kamschatka; 25, Podosira; 26, Navicula didyma; 27, Triceratium; 28, Nits-



BAILEY ON DESMIDS AND DIATOMS.

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chia; 29, Arachnoidiscus; 30, Grammatophora; 31, Biddulphia,—*a*, two frustules, still enclosed by the "connecting membranes," *b*, "connecting membrane," widening previous to self-division; 32, Pleurosigma; 33, Synedra; 34, Coscinodiscus; 35, Triceratium; 36, Amphitetras.

The forms are not accurately drawn to scale, but are for the most part magnified about four hundred diameters.

A BOTANICAL EXCURSION IN MY OFFICE.

BY PROF. HORATIO C. WOOD, JR., M. D.

PROBABLY most of the readers of the NATURALIST have, at some time or other in the last five years, owned, or at least been interested in aquaria. If what happens in Philadelphia may be taken as an index, many such observers of water-life have been pestered by a minute growth, which seems to flourish alike on plant or stick, on the living and dead. Last winter and spring the writer of this article had a small aquarium, which, as far as plants were concerned, was stocked chiefly with the *Ceratophyllum*, or hornwort, which, as is well known, possesses a vast abundance of finely dissected, twig-like leaves. Glancing one day at his water-garden, he noticed on these little cylindrical divisions a fine hazy fringe, scarcely to be perceived except by allowing the light to shine through the vessel containing the plant. Now this fringe, this nebulous garment clothing the hornwort, was the minute growth alluded to, which, though not strictly parasitic, not feeding on the plant to which it is attached, is, in most cases at least, associated with a sickly state of the larger plants, and certainly detracts from their beauty when viewed with the unaided eye, as in aquaria. But let us take our forceps, break off one

of these little twigs, place it on a glass slide, put over it the cover, and carry it to our microscope. For this examination, a power of about one hundred diameters is the most satisfactory, say an $\frac{8}{10}$ or $\frac{3}{4}$ objective. Let me place the object on the stand, adjust the light and focus, and now peer through the eye-glass, and lo! our scarcely perceptible prize starts into view as a huge subaquean forest, or rather cane-brake, with great leafless stems; here and there more sparse and open, here and there more close and impenetrable.

A wonderful land is this we have entered upon,—a land more strange than ever was dreamed of by Eastern romance. It has not only a vastly diversified flora, but also myriad animal forms.

If time and space would allow, we might watch the little groups of Vorticellas, making, by their rapidly-moving cilia, numerous whirlpools, which, to many of the inhabitants of the drop of water, are as fearful as ever maelstrom was to ocean wanderer; for down in the centre of each miniature whirlpool lurks their destruction, towards which the current resistlessly forces them when once within its grasp. Perhaps a huge many-armed hydra might be found lurking in the thickets, or the jelly-like, formless mass of an Amœba writhe itself into ever-varying shapes before us. But we must pass by rotifers, infusoria, entomostracans, arachnids,—all the marvellous animal inhabitants to be seen,—as well as the various diatoms, desmids, and other plants, save the species which is the predominant feature of the scene we have been looking at.

The secret of the intense interest excited by these microscopic objects in any naturalist who has once fairly entered upon the study of them is the fact, that here we

are brought, as it were, face to face with the greatest of all mysteries—*life;* here we see it in its simplest expression, and are able to watch all its processes, to perceive every movement, and, in fact, come as close to the force or forces which constitute life, as the chemist in his laboratory, or electrician in his study, to the forces whose action they investigate. The study of infusoria or of microscopic algæ is not merely, as in most natural history studies, one of form and relation, but rather is it the study of life.

The scope of this paper is not such as to allow anything more than an entrance into this subject just far enough to glance at the beautiful prospect beyond. The plant itself is one of those simple forms which prefigure some variety of vegetable tissue, as seen in higher plants. It is composed of a number of cells placed end to end (Fig. 1), so as together to form a filament.

Fig. 1.

Zoöspore escaping, still surrounded with gelatinous material. *a*, cell in which it was formed; *b*, zoöspore, surrounded with its primary gelatinous envelope.

Let us pause a moment here to learn what a vegetable cell is, if we do not already know. The microscopist has given the name of *cell* to little vesicles, closed spheres, cylinders, or some other hollow forms, which his investigations have taught him, compose the animal and vegetable creation. Mayhap the reader of this article has, at some time in his summer saunterings, sat beneath a giant oak, and, peering into the water rippling at his feet, watched the little green mosses waving in the stream; or, stooping to pick up a pebble, has noticed the dark lubricous stratum on its surface. How different do these seem from the tree that shades him! Yet in their essence

they are the same. That scarcely perceptible speck on the quartz is a vast assemblage of little plants, composed each of but a single vesicle or cell; whilst the oak that towers above is nothing but a vast assemblage of such cells united into a single plant.

All plants, from the lowest to the highest, then, consist of cells, which are essentially the same throughout the whole vegetable kingdom. Let us take a cell of the plant before us, and examine it as a specimen of the vegetable cell.

In the first place, on its exterior we find a dense, but transparent coating, resistant to external force, and apparently structureless. Examine it with our highest powers, and still it is structureless, a homogeneous, perfect membrane, without pores or any interruptions whatever. Yet it is easy to prove that water and various fluids can pass through it. Place the cell in a dense syrup, and the water will be drawn out of it so rapidly, that the contents will shrivel up. Again; the contents of the cell are, as we shall know directly, composed largely of a substance which shrinks and hardens under the action of various substances. Put a plant in diluted acid, or strong alcohol, and see how the contents gather themselves together; or surround it with a solution of iodine, and see how soon the change of color in the most central part betrays the presence of that element. Such experiments as these prove that although the cell wall is absolutely homogeneous, destitute of all pores, yet fluids can pass through it. You see how, in the very onset, we are led into one of life's processes, *osmosis*, as it is technically called; but we must pass it by.

Let us try a little microscopic chemistry. Put a filament on a clean slide, and allow a watery solution of

iodine (dissolved by means of iodide of potassium) to flow round it. Then add a drop of sulphuric acid, and see! the transparent, colorless outer wall has become of a decided bluish or purplish tint. This is the test for *Cellulose*, a substance identical with starch in its constitution, of which the outer wall of *all vegetable cells is composed*. When a plant wishes to store up its material for future use, it throws it into the form of little insoluble granules (*starch*), which are deposited in the cells in various storehouses,—sometimes underground stems, sometimes roots, sometimes leaves, sometimes other parts are selected. When the plant wants to move its material from place to place, it converts it into *dextrine*, which is soluble, and therefore capable of being transported. But when the material is to be finally disposed of, stored away, then it is made to take the form of *cellulose*.

Within the cell, lying immediately against the outer wall, is a thin, gelatinous, scarcely perceptible layer, which is colored brown by iodine, and coagulated and rendered more apparent by alcohol, sulphuric acid, and various reagents; this is the so-called *primordial utricle*, an albuminoid, homogeneous mass, in which much of the life-activity of the cell resides. Inside of this is a semi-fluid mass which is very complex in its constitution, and different at different times. The essential parts of it are *protoplasm* and *chlorophyl*. The former of these is probably identical with the primordial utricle, and shows its wonderful formative power. Chlorophyl is the green coloring matter of plants. It is chlorophyl containing protoplasm, which alone stands between all animate creation and death by starvation. For it is this alone which possesses the marvellous, almost creative power of seizing the inorganic elements and compounds of the earth and

air, and changing them into organic principles capable of life. But to do this, *light* is necessary; it is only by the aid of that force that the chlorophyl can awaken into life the clod and breeze. Without light,—

> "The world were void,
> The populous and the powerful were a lump
> Seasonless, herbless, treeless, manless, lifeless,
> A lump of death,—a chaos of hard clay."

Somewhere in the protoplasm is generally to be found a spot of great refractive power, the *nucleus;* in the cell before us mayhap we can find it close to the wall, maybe it is absent. The nucleus is nothing more or less than a little solid protoplasmic ball. Much importance is assigned to it by most authorities, and in fact it, when present, plays a very important role in the life-history of the cell. But in these algæ it is often absent, and the truth seems to be, that the primordial utricle, nucleus, and general protoplasm are identical in constitution and formative powers. In other words, that they are different manifestations of the same substance.

Now let us place one of our filaments under a high power and examine it closely. Under a $\frac{1}{5}$ objective, we will plainly perceive a very curious phenomenon going on inside of some of the cells. Notice among the general semifluid contents a number of minute dark specks or dots; these are minute granules of protoplasm. See! they are in active motion,—some are busy travelling from one end of the cell to the other, and all along it they are passing one another. But the mass of them are collected in two groups at the ends of their cells; all of them busy bustling about in all directions amongst themselves, reminding one of a hive of bees about to settle.

We have thus in our little plant had a sight of a process, which, variously modified, is probably present in all

vegetable cells during some period of their active life. To these protoplasmic movements the name of *Cyclosis* has been given. Among the higher plants, the hairs of the stamens of the *Tradescantia Virginica*, or Spiderwort, are favorite subjects for the study of Cyclosis.

It is well known, that, in our ordinary flowering plants, there are two distinct methods of continuing the species. In the one case, there is a peculiar system of organs provided, which are in a measure antagonistic to the growth of the individual, and which produce seed, little bodies capable of renewing the life of the species; in the other case, certain portions of the ordinary nutritive organs of plants are set apart to reproduce the species. Thus in our common potato, by means of the flower, with its stamens and pistils, seed is produced; but, at the same time, portions of the underground stem become storehouses of vital force and starch, to serve as material out of which that force may obtain its building stores. Other familiar instances of this changing of the destinies of a part, are seen in the so-called bulbous roots, in the little aerial bulblets of the Tiger-lily,—all of them nothing but ordinary leaf-buds gorged with nutritive materials, and made the depository of vital force, in order to survive the death of the individual, and perpetuate the species.

As it is in the highest plants, so do we find it in the lowest. Unity in diversity seems to be the motto of creation; the broader we extend our studies, the oftener will we find the same ideas outcropping in different forms.

In the little confervoid growth under consideration, then, there are two distinct plans by which the species is perpetuated. The first is by a setting apart of certain ordinary nutritive parts of the plant, the other the specialization of a peculiar set of organs.

Let us study the former of these. Imagine our plant under the microscope, just as some one or more of its cells are to be sacrificed for the production of a new life. Watch that cell. See the endochrome, or green contents, gathering itself by an imperceptible motion into a condensed mass at the distal end of the cell. Now a separation is evidently taking place between this cell and the next at its distal end. Slowly they part from one another, remaining attached at one corner, so as to open like a hinge until the sundered parts, instead of being in one continuous line, lie side by side more or less parallel to one another, and a free opening is left at the end of the cell. Slowly the mass of endochrome continues to move, so slowly, that, even with a very high power, the motion is imperceptible. Perchance the outlet seems too narrow for it, and, in twisting itself out of it, the plastic mass assumes various shapes constricted in the middle where the orifice is. It continues, however, to advance, until at last it is out of the cell in the free ocean around it. (Fig. 1.) It now recovers very quickly its shape, and is a bright green, globular or oval mass, with a little transparent spot at one end. As I have seen the species under consideration, this little ball is at first coated with a transparent gelatinous material, which rapidly dissolves off in the water. Let us keep our eye still fixed on the ball. See! the coating is nearly gone, and, is it true? the little ball begins to rock without apparent cause. Now it rocks faster and faster, and now it is gone out of the field like an arrow. Here it comes back, moving hither and yon, now very rapidly, now with a slow laterally rolling

Fig. 2.

a

A zoöspore shortly after germination, of a species of Œdogonium growing in springs around Philadelphia. *a*, root-like processes growing at the ciliated end of the zoöspore.

Fig. 2, *c*

Zoöspore killed to show its cilia.

motion. The plant has given birth to an offspring possessing apparently the peculiarly animal power of spontaneous motion. Let us now place a little solution of iodine or laudanum so that it will come in contact with our little moving body, and in a moment motion ceases, —we have killed it!

Let us now carefully arrange our light, illuminating the stage a little obliquely, put on our $\frac{1}{5}$ objective, adjust it for the glass cover, and see if we cannot discover the cause of the motion. Do you not see a circle or crown of long, lax, streak-like particles attached around the bright transparent space before spoken off. These are *cilia*, fine threads of condensed protoplasm. If during life one of these motive bodies is placed in a liquid containing very fine particles, as a dilute solution of India-ink or gamboge, and watched, constant currents will be seen to be produced by these cilia, which are in such rapid motion that they cannot be otherwise detected. It is, then, by virtue of the constant lashing of the cilia, that the little body moves, just as a boat moves by means of the scull. The movement of the cilia themselves is not a voluntary one; it is a form of the protoplasmic movements, of which cyclosis is one type.

Let us take our motive body, killed by means of the iodine, and add sulphuric acid to it; if cellulose be present, a bluish or purplish color will be produced. But there is none. In other words, our little body is composed simply of protoplasm and chlorophyl; it is a cell without a wall. To these moving bodies the name of zoöspore is given. If you watch a living zoöspore, in a little while its motion ceases, its cilia drop off, and it surrounds itself with a cellulose wall.

In most plants allied to the species under consideration,

from the position of the cilia (Fig. 2) there grow, during this process of germination, little root-like processes which attach themselves to some anchorage, but I have not been able to detect them in the aquarial inhabitant. The cell, having acquired a wall, and thus perfected itself, now begins to elongate; by and by it undergoes cell division, and thus divides itself in its length into two cells, which grow and divide, and by repetitions of this process, the filament is formed, that which we noticed at first. This plant belongs to the genus *Œdogonium*, the species of which are arrangeable into three sets; first, those in which the single filament produces both male and female organs; secondly, those in which male and female organs are produced in distinct filaments; thirdly, those in which the female filaments produce, besides the regular zoöspores, others which, in germinating, grow into peculiar dwarf plants, in which are formed the male germs. These three sets are known respectively as *monœcious*, *diœcious*, and *gynandrosporous* plants; the term androspore being given to the zoöspore, whose function is to grow into the little dwarf male plant. The Œdogonium of the aquarium belongs to the gynandrosporous division.

Besides these zoöspores the Œdogonia produce, by means of a specialized reproductive system just alluded to, a spore or seed which is known as a *resting spore*. In our plant this is produced as follows: a cell in the main filament begins to enlarge, and, at the same time, a communication is opened between it and the next proximal cell, whose endochrome is emptied into it. The two consolidated endochromes now contract themselves into a roundish ball in the swollen cell, the sporangia or spore-case. About this time several of the *androspores* (Fig. 3) attach

themselves generally on the emptied cell (Fig. 3), sometimes on the sporangium, and soon grow into a peculiar two-celled little plant. The base of the first of these cells is enlarged into a roundish, disk-like part, which is attached to the anchorage, and is known as the *foot*. It is the distal of the two cells in which are formed the male germs, the so-called *spermatozoids*. These are little bodies very similar to the zoöspores, but much smaller, and almost destitute of color. They are similarly ciliated, and have similar powers of locomotion.

Fig. 3.

A portion of a female plant with its spore just fertilized, and a dwarf male plant on the emptied cell. *a*, dwarf male plant; *b*, sporangium with its contained spore; *c*, opening through which spermatozoids enter; *d*, cell whose endochrome has been used in making the spore; *e*, spermatozoids (out of proportion in regard to size).

About the time that they are perfected, there is formed a lateral opening in the proximal or lower part of the sporangium of the resting spore. Through this orifice one or more of these spermatozoids enters and impregnates the endochrome, which contracts itself still more, and matures into the fully formed resting spore. During its maturation its green color changes into a reddish-brown, and it acquires two coats, the outer of which is very thick and provided with a curious spiral band or marking. (Fig. 5.)

Fig. 4.

Young dwarf male plant magnified about 1,000 diameters. *a*, foot; *b*, main body of the primary cell, with granular protoplasm in very active motion,—direction of the currents shown by arrows; *c*, newly-formed cell, very delicate, scarcely perceptible above.

The exact way in which germination of the resting spores takes place in the genus

Œdogonium, has never been determined. In the allied genus *Bulbochæta*, the resting spore finally breaks up into zoöspores, which grow into the plant in the same way as other zoöspores.

Fig. 5.

Portion of female filament with spores. *a*, immature; *b* and *c*, mature, showing spiral band.

If we examine our filament closely, we will find it terminated by a long, exceeding delicate, bristle-like hyaline point, composed of cells whose walls are so delicate, as to be scarcely perceptible with very high powers, and at the end apparently consisting simply of primordial utricle, though I confess never to have accurately determined this by micro-chemical tests. Again, if we look at some of the large cells of the filament closely, we will find near their distal end one, two, three, or more streaks surrounding them like so many collars. Let us look still more closely. Why! such cells evidently have their wall beyond the first streak or line thickened, in fact bear on their upper ends little caps, as it were, the lines being in the caps. The causes of these two phenomena, the hyaline point and the little caps, are to be found in the peculiar methods of growth of the Œdogonia. The larger cells increase by a variety of *cell multiplication by division*. Cell multiplication by division is almost the only way in which all vegetable growth takes place. The process, as it ordinarily occurs, may be outlined in a few words. If a cell, about to undergo it, contains a nucleus, the first change takes place in that nucleus; a constriction can be seen encircling and increasing in depth, until the nucleus is divided into two. When this has taken place, a doubled reflection from the primordial

utricle grows inwards, and, dividing the protoplasm and contents more and more completely, finally meets in the centre, and the single cell has been divided into two, each half of the original size. These small cells now increase in size by an interstitial growth of their cell-wall until they reach their full size, when, perchance, the process recommences. Sometimes a globular cell will divide into three, four, or more parts, but the process is essentially the same. In *free cell formation*, the protoplasm of a cell condenses into a varying number of little masses, which, whilst lying free in the interior of the mother cell, secrete, each around itself, a cellulose wall. In this way is formed a number of perfect cells, enclosed in, but independent of, the original cell, by whose dissolution they are finally set free.

Fig. 6.

Two cells taken from a species of Œdogonium growing in the neighborhood of Philadelphia, not the aquarial one. *a*, cell in which division is about to take place above,—the dark line or streak showing; *b*, young cell bearing the remains of old cell (*c*) on it; *e*, its endochrome; *w*, its newly formed cellulose wall; *d*, old cell from which it has separated.

But let us return to our little plant and observe together a cell about to divide. The first noticeable change is the appearance of a dark streak around the cell near the distal end. At the position of this streak outgrowths take place from the primordial utricle as just described, and divide the old cell into two parts, the upper being much the smaller. (Fig. 6.) Watching the dark streak just spoken of, in a little while it begins to widen into a trench, and still continues to widen; the upper smaller division is growing by an elongation of the primordial utricle at the line of separation of the two parts. As the primordial utricle grows, it bears the old cellulose wall, like a cap upon its end; and, when it secretes its own proper cellulose wall, the

latter is of course inside of this. When the newly formed cell has attained its full size, it recommences the process again. The dark line now appears just below the edge of the old cap, and gives origin to the edge of the second cap, that of the former remaining apparent as a dark line. Again the process is gone through, and a third cap is formed, the margins of the first and second persisting. And so repetition after repetition, until a cell is formed bearing on its end a cap which is ringed with half a dozen dark lines, and composed of as many layers of cellulose. The dark rings of course mark the edges of the successively cut off ends of cells. If there be six such lines, cell division has taken place six times since the original was formed. (Fig. 6.)

Fig. 7.

End of a filament, showing hyaline point.

Whilst the cells near the base are thus lengthening the filament by their increase, the end cell seems to grow by a sort of out-pushing of the primordial utricle from the central part of the fore end. This makes a little cylinder, which is soon cut off from its parent cell by a partition, secretes a cellulose coat, and then pushes out a new shoot from its free end, just as itself was formed. By a repetition of this, a series of cells is made, each of which is smaller than the proximal one; and, finally, the filament is drawn out into a fine hyaline point. (Fig. 7.)

Fig. 8.

Perfected spore of the species from which Fig. 6 is taken.

THE QUADRUPEDS OF ARIZONA.

BY DR. ELLIOTT COUES, U. S. A.

(Concluded from p. 400.)

FAMILY *Hystricidæ*, the Porcupines. The yellow-haired Porcupine (*Erethizon epixanthus*) is a large and handsome species, which replaces the common one in the Western regions. Besides being somewhat larger than the last, there are differences in the color of the hair and quills, and some peculiarities of the cranial bones. I believe nothing has been observed regarding its habits whereby it differs from the Eastern species (*E. dorsatum*). It is particularly abundant along the Colorado Chiquito River, and nearly all our explorers have obtained one or more specimens in that vicinity.

Family *Leporidæ*, the Hares. Two species of the family are very abundant, and generally distributed over the Territory. These are the Great "Jackass" Hare (*Lepus callotis*), and the Sage Rabbit (*L. artemisia*). Certain other species, as *L. Californicus*, in the Colorado Valley, or *L. campestris*, in Northern Arizona, may possibly occur; but the two first named are the only common and characteristic ones.

The Jackass Hare includes in its extensive range nearly all the great Western prairies extending into Texas and New Mexico, and is, in places suited to its wants, a very abundant animal. In some desert regions it and the Coyoté are almost the only animals of any size to be found, and it is difficult to imagine how they derive nourishment from such forbidding localities. It must feed largely upon sage-brush, grease-wood, kreosote-plant, young mimosas, and the like; for these constitute the main features of

the flora over large tracts, where grasses and succulent herbs are mostly wanting. Its flesh is said to derive a bitter taste from this sort of food; though I have eaten these hares from various regions without noticing any difference in their quality. At Fort Whipple, the species is very common the year round, and almost every sort of locality is frequented by them, though they chiefly affect grassy meadows and open glades, interspersed with copses, or clumps of oak trees, or patches of briery undergrowth. The gulches or "washes" as they are called, leading out of mountain ravines, and thickly set with grease-wood (*Obione canescens*), are favorite resorts. They feed much upon this plant; and by their incessant coursings through patches of it, they wear little intersecting avenues, along which they ramble at their leisure. When feeding at their ease, and unsuspicious of danger, they move with a sort of lazy abandon, performing a succession of careless leaps, now nibbling the shrubs overhead, now the grass at their feet. They are not at all gregarious, though peculiar attractions may bring many together in the same spot. They do not burrow, but construct a "form" in which they squat. I do not think these are permanent; but rather that they are extemporized, as wanted, in some convenient bush; though the case may be different during the season of reproduction. It has been stated by some authors, that only two or three are produced at a birth, which I know to be at least not always the case, having found as many as six embryos in the multipartite womb of a pregnant female. In the latitude of Fort Whipple the young are brought forth in June.

Although so timid, like all hares, this species will admit of a very close approach when it fancies itself hidden

in its form; though it hardly squats so pertinaciously, nor is it so easily concealed as the little Sage Rabbit, on account of its size. Trembling at heart, yet with motionless body and eyes intently regarding the intruder, it sits all doubled up, as it were, the head drawn in, and the long ears laid flat upon its back, until one may almost touch it, when, with a great bound, it straightens out, clears the first intervening bush, and is off like the wind. It has a long swinging gallop, and performs prodigious leaps, some of them over bushes four feet high; now in the air, its feet all drawn together and down stretched; now on the ground, which it touches and rebounds from with marvellous elasticity. It will course thus for a hundred yards or so, and then stop as suddenly as it started; and, sitting erect, its long wide open ears, vibrating with excitement, are turned in every direction to catch the sound of following danger. The eye and hand of the sportsman who would cut short the first rush of the Hare must be quick, or he will be more likely to behold only a "rear elevation" of his game than to see it lying upon its side in the agonies of death, playing the prelude to its last appearance, in the culminating scene of its brief life's drama.

The skin of this species is very thin, tender, and easily torn, and nearly worthless for any practical purpose. After parted with by its owner, it is only fit for a naturalist to puzzle over, in the attempt to determine its species. In the regions where I studied the animals, there is no appreciable difference in color, between summer and winter pelages. They are always yellowish fulvous above, grizzled with gray, dusky, and black; and dull white below, tinged with fulvous on the throat. There is a longitudinal stripe of pure black on the rump, and ex-

tending on the upper surface of the tail; the under surface of which, as well as the surrounding parts, are white. The long ears are mostly grayish, or slightly fulvous, their posterior margins pure white, and their broad ends pure black for an inch or more. This parti-coloration heightens the conspicuousness which their size alone would give them.

The Sage Rabbit (*L. artemisia*) is as abundant in Arizona as the Jackass-rabbit; and, like the latter, has an exceedingly extensive range throughout the West, from the Missouri region into Mexico, wherever the sage-bush, and other desert shrubs are found. It seems rather to avoid rich, grassy, and well-watered regions, and to take up its abode in the most sterile and desolate localities. Besides ordinary desert tracts, it shows a fondness for rocky, broken, and precipitous places, such as are usually shunned by the larger species, though the two are often found side by side. It burrows in the ground, and also lives under rocks, or in the crevices between them. It is a squat, bunchy little species, and its gait differs greatly from that of the hare. It runs close to the earth, and instead of bounding over obstacles, scuttles around them with great agility. It is quite as difficult to shoot as the Jackass; for although slower of foot, yet it runs in a more tortuous and zigzag course. It squats so pertinaciously in its hiding-places, that a small bush may be kicked several times before it will come out. It may not be generally known that this species, at least in some localities, changes its colors considerably in winter. At Fort Whipple I procured one in January, whose fur was very long, thick, and soft, and without a trace of the brownish or fulvous so conspicuous in summer. It was pretty much all over of a clear mouse or steel gray,

which, on various parts, particularly the belly and limbs, passed into white, more or less pure.

Order *Ruminantia*, the Ruminants. Both naturalists and hunters distinguish two species of Deer in Arizona, called the Black-tailed and the White-tailed. Of these the former is by far the most abundant and characteristic; although, judging from accounts formerly given of it, it has considerably decreased in numbers owing to the persecution to which it is subjected so constantly from both the native tribes and the white settlers. It is the *Cervus macrotis* of Mr. Say; and is also called the "Mule Deer," from the length of its ears. A novice, on seeing it for the first time, running directly from him, would hardly think to call it "black-tailed," but rather the reverse. The black exists only on the upper surface of the tail, and near the end; and, as this member is ordinarily elevated and vibrated from side to side as the animal bounds off, only the white of the under surface and neighboring parts is exposed to view. This deer forms no small share of the food and clothing both of the Indians and white settlers. The former have as yet not generally obtained fire-arms, and in the chase resort to a peculiar stratagem, to be more particularly noticed in speaking of the Antelope. That their artifice is ordinarily successful is abundantly proved by the numbers of buckskins to be found in their rancherias. They possess the art of dressing them very perfectly, which is the more remarkable considering the primitive means they employ. Unlike the skins of lynxes, foxes, etc., those of the deer have the hair removed, and are dressed as cloth, to be used for a great variety of purposes besides clothing.

The horns of this species differ somewhat in configuration, though not materially in size, from those of the Vir-

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The horns of this species differ somewhat in configuration, though not materially in size, from those of the Vir-

ginian, or of the Columbian Deer. At their roots they are corrugated and nodulated for a short distance, when a small curved basal snag is given off. Near the middle they fork into two about equal branches, being widened and flattened just at the point of divarication. Each of these branches is again dichotomous not far from its middle, one of the terminal forks being ordinarily larger than the other. The whole amount of curvature of the main stem of the antler is rather less than in some other species. The horns are shed in the spring, and the new ones are in the velvet during the great part of the summer. By October, both sexes have finished changing their light coarse summer vesture for the softer and thicker winter coat, which, for some time after the change is completed, is extremely sleek and glossy. Its color is darker than it is in summer, being chiefly mouse-gray, finely waved or annulated with lighter and darker shades. In summer, there is much of a brownish or even fulvous tinge on many parts. The fawns are brought forth in June or July, either one or two at a time. They are at first of a light reddish-brown,—whence our familiar term "fawn-color,"—beautifully spotted with pure white, which is mostly disposed in straight rows.

Except at certain seasons, this deer is more apt to be found singly than in herds of any size. But frequently in the autumn two or three are seen together; and on one occasion in October, I enjoyed the rare sight of twenty or thirty feeding together in a little open glade among thick pine woods. It is not an inhabitant of open prairie land, and is but rarely to be seen in such situations. Thinly wooded tracts of country, interspersed with oaks or junipers; hills and mountain sides covered with pines, as well as those places known as "chaparrals," are its favor-

ite resorts. In warm weather, and particularly during the heat of the day, after its morning graze and drink, it is fond of repairing to the thickest brush, where it lies down, and doubtless sleeps, as at such times it may be more easily and nearly approached than at others.

I cannot positively determine the White-tailed Deer of Arizona, as I never procured a specimen. It may be a race of *C. Virginianus*, or that species called *C. Mexicanus* in Professor Baird's work, or not impossibly the *C. leucurus* Douglass. The white-tailed deer of our continent are all so closely allied, that it requires a practised eye and patient labor to distinguish them with any degree of certainty; and I believe it is a question with some, whether they all are not merely local races of one common stock.

Though the dry plains of Arizona are not frequented by deer, still they are not wanting in inhabitants among the beasts "that cleave the hoof." Over them the Prong-horned Antelope (*Antilocapra Americana*), the swiftest animal of America, runs races with the winds, making the long miles shrink into mere spans at the touch of his almost magic hoofs, whose impress upon the green sward writes down, in wild yet graceful stanzas, the "poetry of motion" which every attitude and movement of his supple form embodies. As on the land-sea of the Great Plains, so on every land-lake of Arizona he is at home; for home to him means the grassy surface of the earth, where his food is under and around him, and water may be reached by a bagatelle canter of a score or so of miles.

Every one has heard of that strange trait of the Antelope's character, which leads it irresistibly to approach any unusual object which it cannot make out, for a nearer view of the thing which so forcibly excites its astonish-

ment as to overcome its natural timidity. This remarkable curiosity is taken advantage of by hunters, to lure the animal within range, by displaying some brightly-colored piece of cloth, while they lie concealed close by, rifle in hand. The shallower the artifice, the more it seems likely to succeed; a handkerchief fluttering from the end of a ramrod, or even the hunter himself standing on his head and gesticulating with his heels, have compassed the death of many an antelope. But the Indians seem rather to surpass the white man in ingenuity, or rather in a sort of instinctive sagacity, perhaps born of necessity; and take advantage, not only of the common weaknesses of the species, but of that emotion or rather passion which at times absorbs all others, as it should, since on it depends the maintenance of the species, while the rest affect the life of an individual alone. They skin the head and neck of a buck antelope, and stretch the skin, after proper stuffing and drying, upon a light framework, the bottom of which is a hoop which fits their own heads. The horns are scraped or shaven, until they are thin and light, though still preserving their shape. This primitive taxidermy produces an imitation of an antelope's head, which at a little distance is very perfect, and the artifice is very successful during the rutting season. Concealing their bodies, the hunters expose the false mask, and imitate the motions and noises of the now pugnacious and easily excited buck. The latter, flushed with sexual vigor, hears the challenge, and sees the menacing attitudes of his supposed rival, upon whom he advances to offer battle in the cause of the object of his passion, who may be feeding quietly near by, affecting not to notice the fiery zeal of her lord. The bowstring twangs, and the feathery shaft does its bloody work for

him; while she bounds off, with terror and regret, and soon solaces her *ad interim* woe with another conquest.

This animal takes its common name from the peculiar shape of its horns, which have a single somewhat triangular prong jutting from near the base or middle of the shaft, and sometimes flattened or somewhat bent like a scroll. But the position of this prong, as well as its shape and size, varies greatly; while the length and apical curvature of the main shaft is equally variable. Scarcely any two pair of horns are precisely similar in these points, and a second species has even been characterized upon these differences alone. The curious reader will find a great variety figured in Plate XXV. of Professor Baird's work. A pair which I obtained in Arizona were of very unusual shape. They were most like Fig. 890 *a* of the plate referred to, having a very large, flat, triangular prong springing from their very bases; but their tips bent over till they pointed directly downwards, in a direction quite parallel to the axis of the shaft, which is a degree of curvature rarely seen. It is scarcely necessary to add, that the Antelope's horns are not deciduous, like the antlers of the deer, but permanent, like the horns of rams and bulls.

Arizona has woods and plains which are roamed over by the deer and antelope, but a great portion of her territory is unfitted for either of these, being upheaved into lofty mountain ranges and precipitous cliffs, or rent asunder in yawning chasms, and rocky cañons, by the rude shocks it has undergone through the convulsive violence of volcanic action. Masses of plutonic rocks are piled up in wild confusion, and black lava vomit is poured over miles of surface. In the most rugged and broken regions, rarely visited by man, or inaccessible to him, and

amid scenes that are terribly grand in their frowning desolation, is the favorite home of the Rocky Mountain Sheep (*Ovis montana*). Fearless and intrepid, fully trusting his powers, he stands in bold relief upon the edge of some abyss,—his massive horns, and towering form, and sinewy limbs clearly delineated,—the centre-piece of a great picture whose background may be a mountain or the sky itself. He stands a fitting headstone for the graves of the Titans, now quietly slumbering beneath the mighty monuments they erected to their own memory with their last convulsive throes.

The Mountain Ram has a very extensive range, which includes nearly all the elevated mountains and broken regions from our northernmost Territories into Mexico. In Arizona it has been formerly much more abundant than now, for though it still exists in the more inaccessible portions, it is rarely to be seen. But its great horns may be found scattered about the bases of nearly every cliff and precipice.

There is abundant evidence that the Buffalo (*Bos Americanus*) formerly ranged over Arizona, though none exist there now. The habitat of this "monarch of the plains" is contracting year by year, and its numbers are gradually diminishing. Like the Indian, the buffalo seems doomed to disappear before the overwhelming tide of advancing civilization, and must before long, though not in our day, be known only in history. The nature and needs of both are diametrically opposed to the spirit of the white man's progress; and in the inevitable conflict,—with them for bare existence, with us for supremacy,—they cannot hold their own. Sad spectacle, this passing away of a race of men, and of a species of animal; yet in strict obedience to an inexorable, mysterious

law of Nature, which determines the origin, duration, and ending of every form of animal life, by the operation of forces of which we can see dimly some disjointed fragments, but cannot hope to ever wholly comprehend.

THE LAND SNAILS OF NEW ENGLAND.

BY EDWARD S. MORSE.

(Continued from page 414.)

THE following species belong to a group of small snails, whose thin polished shells furnish a distinguishing character. *Helix indentata*, described in the October number, belongs to this group. We promise that those who may have become interested in these papers will find the task of identification growing more and more difficult as we proceed, as with few exceptions the shells have very few distinguishing marks, and the differences are only prominent to those who make it a study.

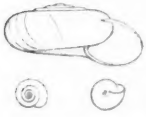
HELIX CELLARIA *Müller*. (Fig. 29.) The shell of this species is flattened; spire depressed, shining; whorls five, thickened within at the base; color pale horn, opaque white below. Diameter less than half an inch. Animal light indigo-blue, darker on head and tentacles. This species is not a native of this country. It has been imported from Europe to our shores through the medium of commerce. As these snails are generally confined to cellars and gardens, their eggs have probably been brought to this country on wine-casks or on the roots of hot-house plants. In a previous number we have dwelt on the extreme vitality possessed by the eggs of this family. A lady in Portland, in whose cellar

Fig. 29.

the writer collected a great many, stated that the snails annoyed her by crawling into her pans of milk. We can well imagine an enthusiastic collector delighted in being able to dredge specimens from the bottom of his coffee-cup at the breakfast table!

Another species, a true native however, though much resembling an English species, is HELIX ARBOREA *Say*.* (Fig. 30.) This is extremely common in New England, and there is hardly an old log by the roadside but that shelters them. The shell is thin, pellucid, polished, and of a brownish horn-color; whorls four to five, slightly increasing in size. Umbilicus not large; diameter about one-sixth of an inch, though occasionally larger.

Fig. 30.



HELIX ELECTRINA *Gould* (Fig. 31) resembles the last species somewhat, being of the same size, though its color is darker, and the whorls rapidly enlarge. In this latter character it resembles *Helix indentata*, though differing from that species by its dark smoky horn-color, and its open umbilicus. It occurs in damper situations, oftentimes under leaves near stagnant pools of water.

Fig. 31.

HELIX BINNEYANA *Morse* (Fig. 32) resembles *H. indentata* very much, and has always been confounded with that species; it differs in always having an open umbilicus, and the color is different, being a greenish white, while *H. indentata* is white, with a pinkish tinge. The differences are very marked in certain microscopical characters of the animal.

Fig. 32.

*The smaller figures accompanying the cuts represent the natural size of the shell.

HELIX MULTIDENTATA *Binney*. (Fig. 33.) This is one of our most beautiful species. The shell is less than an eighth of an inch in diameter, the whorls are six, very closely revolving, and at the base of the shell within are seen two or more rows of teeth radiating from the umbilicus. The shell is of a very light horn-color, and the animal is often rosy white. It is extremely rare, having been found but sparingly in Maine, Vermont, New Hampshire, New York, and Ohio.

Fig. 33.

Another charming shell, when viewed under a microscope, is HELIX EXIGUA *Stimpson*. (Fig. 34.) The shell has four whorls, banded by numerous sharp ribs, and the spaces between marked with waved lines running parallel to the whorls. The umbilicus is very wide, and the color of the shell a decided greenish white. Diameter about one-tenth of an inch. This species occurs in nearly all the Northern States; in some places quite commonly.

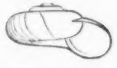
Fig. 34.

HELIX MINUSCULA *Binney*. (Fig. 35.) About the size of the last-named species, having four whorls; suture quite deep; umbilicus large; color white. It is common in the West, but extremely rare in the Eastern States. It is said to be very common in grass in the gardens of Cincinnati, Ohio. Rev. E. C. Bolles has recently found a number of specimens in the State of Maine.

Fig. 35.

HELIX MILIUM *Morse* (Fig. 36) is a very minute species; the whorls rapidly enlarge; umbilicus quite large. The upper surface of the shell is reticulated by slightly raised ribs, and wavy revolving lines. The under surface is shiny; color greenish-white. Diameter one-twentieth

Fig. 36.



of an inch. This little species, first described by the writer from specimens found in Maine, has since been discovered in Massachusetts, and two specimens have recently been received from California, one from San Francisco, and the other from the Sierra Nevadas, showing an unusually wide distribution.

HELIX FERREA *Morse* (Fig. 37) is slightly larger than *H. milium*, and has a steel-gray tinge, and an outline more like *H. electrina*. It has been found in Maine, Massachusetts, and New York.

Fig. 37.

HELIX CHERSINA *Say*. (Fig. 38.) A very characteristic species. The shell is conical, thin, polished, amber-colored; extremely fragile. Whorls five to six, rounded. Base convex; aperture narrow; umbilicus absent. Diameter one-tenth of an inch. This species occurs in nearly all parts of the United States, and is quickly recognized by its turreted and fragile shell.

Fig. 38.

The shells of the following group are not smooth and polished as in the majority of those just described, but many of them are coarsely striated, and a few have reflected lips. They are all quite small, and variable in form, certain species having an elevated spire, while others are quite flattened. The denticles on the tongue are not claw-shaped as in those previously described, but are notched like a saw.* All the species are very characteristic, and easily recognized.

HELIX MINUTA *Say* (Fig. 39) has a little white, translucent shell, with four rounded whorls, the last one flaring at the aperture. Aperture nearly surrounded by a broad reflected lip. Umbilicus large. Diameter one-tenth

Fig. 39.

*The tongue of a snail was described in the first number of this Magazine.

of an inch; animal whitish. This species is closely allied to *Helix pulchella*, of Europe, and by many authors is considered the same, though we believe them to be distinct. The two species have an extreme range through the northern hemisphere. It is found plentifully about old stone-walls in gardens, and in grass on banks of rivers.

HELIX STRIATELLA *Anthony*. (Fig. 40.) Shell depressed, convex, thin; light horn-color. Whorls about four, with delicate oblique striæ. Suture distinct; umbilicus very large; lip thin. Diameter less than one-fourth of an inch. Animal lightish-blue above, with brownish dots. Creeping disk yellowish white. Occurs throughout the Northern States; very common in New England in hard-wood growths, and under chips and logs by the country roadside. The shell is quickly recognized by its satin lustre, and the distinct striations upon its surface.

Fig. 40.

HELIX LABYRINTHICA *Say*. (Figs. 41, 42.) Shell minute, conic, apex obtuse; brownish horn-color. Suture distinct; whorls six, with well-marked ribs following the lines of growth. Lip thickened, reflected; base flat; umbilicus small. Within the aperture are six revolving ribs, terminating some ways within the aperture. Three of these are on the body whorl, one on the umbilicus region, and two at the base of the aperture. Under the microscope, the three ribs on the body whorl are seen to be armed at intervals with numerous sharp-pointed processes, pointing towards the aperture. Diameter of shell one-tenth of an inch. Animal bluish black. Found in nearly every State in the Union.

Figs. 41, 42.

This is a very characteristic species, in outline similar to *Helix chersina* described above, though differing in the coarse ribs, the reflected lip, and the peculiar teeth within the shell. The young shell (Fig. 42) is quite flat, with the outer whorl sharp.

HELIX ASTERISCUS *Morse*. (Fig. 43.) Shell minute, having four rounded whorls banded by twenty-five to thirty thin transparent prominent ribs. Spire flat; suture deeply impressed; lip sharp. Umbilicus quite large; color light-brown. Diameter one-sixteenth of an inch; animal bluish-white. This little species, first discovered in Maine by the writer, has since been found on the Hudson River, N. Y.; on the northern shores of Lake Superior; Gaspé, C. E.; and in the vicinity of Salem, Mass. Rev. E. C. Bolles has found it plentifully near Portland. It is a rare shell, and seems confined to wet and boggy ground, where spruce and pine is intermixed with alder.

Fig. 43.

HELIX LINEATA *Say*. (Fig. 44.) Shell very small, discoidal, light greenish in color. Whorls four, equally visible on both sides of the shell, having a series of raised lines revolving with the whorls. Umbilicus wide; aperture narrow, on the outer wall of which are two pairs of minute white teeth, one pair more remote. Diameter one-eighth of an inch; animal white, thread-like. Inhabits all the Northern States, though not common in the West. In New England, a very common species along country roadsides.

Fig. 44.

HELIX MINUTISSIMA *Lea*. (Fig. 45.) This is the smallest land shell in the country, measuring only six-hundredths of an inch. The shell is subglobose, spire

slightly elevated; below convex; umbilicus large; suture impressed; whorls four; lip sharp; color light brown. First discovered in Cincinnati, Ohio, and since found in various places throughout New England. This species is not uncommon, though owing to its extreme minuteness is not often found. The writer has separated this into a distinct genus, from the fact that the jaw is composed of sixteen distinct pieces, and not one solid plate, as in other snails. For reasons already given, the species are described under their old generic names. — *To be continued.*

Fig. 45.

REVIEWS.

ENUMERATION OF HAWAIIAN PLANTS. By *Horace Mann.* (From the Proceedings of the American Academy of Arts and Sciences, Vol. VII., 1866.) Cambridge, July, 1867. 8vo. pp. 92.

The collection which forms the basis of this enumeration was made during a visit of over a year to the Hawaiian Islands. The enumeration, consisting of a list of the entire known flora of land-plants, with descriptions of new genera and species, is prefaced by a sketch of previous botanical explorations in these islands, with a description of the physical geography of the five islands visited by the author, and remarks on the distribution of the plants, which latter depends on the distribution of heat and moisture, and the elevation of the soil. The wet region of Hawaii, for example, extending on the eastern side of the island, from a height of 1,500 or 2,000 feet, to about 5,000 feet,* is the most heavily wooded of the group. The parts between 1,500 feet and

* "The summits of West Maui, Oahu, and Kauai, lying between the heights of 4,000 and 6,500 feet, are just in the cloud level, and, being also peaks where denudation has long been active, the soil has become somewhat impervious to moisture, which therefore remains on the surface. The region has a peculiar aspect, which is at once recognized in ascending the mountains. The only forest-tree, the ohia lehua (*Metrosideros polymorpha*) becomes stunted; the trunks are covered with a thick coating of *Mosses* and *Hepaticæ*, which retains the moisture so as to render everything dripping wet; and not more than a dozen species of flowering plants and ferns occur in the whole. Above this, on the mountains of West Maui and Kauai, there is an open tract, where the lehua, one of the largest forest-trees at an elevation of 2,000 feet, has become dwarfed, a foot or two high, in spreading clumps, but still flowing luxuriantly. In the midst of such clumps are found the violets peculiar to these regions, and in the neighboring tussocks of sedge (an *Oreobolus*) are found the few other plants, which occur here and nowhere else, to the number of eight or nine; also *Drosera longifolia*, thousands of miles from its next nearest known habitat."

the sea-level comprise comparatively few species, and but little of the peculiar vegetation. The high and dry mountain tracts, above 4,000 or 4,500 feet, are very distinct in their character and vegetation from either of the regions below. The highest lava summits are nearly destitute of vegetation.

There appear to be about seven hundred species of Flowering Plants, Ferns, and Club-mosses (including the fifty Grasses, which are not yet worked up, being still in the hands of Colonel Munro), indigenous or well-established in the islands,—a large portion of which (nearly two-thirds) are quite peculiar to them. The Lichens are catalogued by Professor E. Tuckerman, who states that "a large proportion of our knowledge, especially in the crustaceous groups [comprising those forms which grow closely, adhering to rocks or the bark of trees, and cannot be removed without crumbling up] is due entirely to his [Mr. Mann's] researches, directed, as they were, by previous study of North American Lichens."

MANUAL OF THE BOTANY OF THE NORTHERN UNITED STATES, INCLUDING THE DISTRICT EAST OF THE MISSISSIPPI AND NORTH OF NORTH CAROLINA AND TENNESSEE. Arranged according to the Natural System. By *Asa Gray*, Fisher Professor of Natural History in Harvard University. Fifth Edition. With twenty-five plates, illustrating the Sedges, Grasses, Ferns, &c. New York: Ivison, Phinney, Blakeman, & Co. Chicago: S. C. Griggs & Co. 1867. pp. 701. [*Not* including the Mosses and Liverworts, nor the "Garden Botany."]

It must be gratifying to all lovers of Botany that the science is so widely studied as to warrant a new edition of Dr. Gray's Manual; and it is no less gratifying to students, that it makes its fifth appearance in public in such an elegant form. It is brought up to the latest and highest knowledge of the day, and its comprehensiveness, accuracy, clearness, and simplicity, its abundant synopses and analyses, its admirable plates, and its clear and well-contrasted type, make it altogether a most important acquisition to our botanical literature.

With this volume in hand, one can travel from Maine to Virginia on the coast, and westward to the Mississippi, and find therein lucid and ample descriptions of all the flowering plants he may meet in that extensive area. Everything in the way of botanical discovery in this country has focussed upon Dr. Gray's table; and the result is, that his new edition is not a mere reprint, but a rewriting of the whole work, with important and significant changes. The nomenclature of our Flora has suffered much variation, and now this last publication upon it has again made numerous alterations. Dr. Gray has, with a com-

prehensiveness which distinguishes him, swept away several of the trifling divisions which have been erected between close kindred. Some ten orders have been merged in others, and more than a score of genera have been similarly dropped out. We can now call the little *Houstonia* by its old familiar name again, and forget the flavor of *Oldenlandia* in our mouths. Those who have measured the angles of orchid anther-glands to see what degree or proximity might entitle the bearer to this or that name, will find that *Gymnadenia* and *Platanthera* are no more; but that they resurrect in *Habenaria*. Whether an anther may turn its face or back to you will not now win for it an ordinal title of *Melanthaceæ*, for it belongs to the large number of *Liliaceæ*. And no one will be longer vexed with the protean forms of oak-leaves, which have swayed him between black and scarlet, for *Quercus tinctoria* is now only a variety of *Q. coccinea*. *Alsine*, *Mœhringia* and *Honkenya* are now *Arenaria*; *Oxalidaceæ*, *Balsaminaceæ* and *Limnanthaceæ* are now all *Geraniaceæ*; *Grossulaceæ* and *Parnassiaceæ* are now *Saxifragraceæ*. As an offset to this absorption of names, Dr. Robbins has increased the twelve species of *Potamogeton* of the last edition to twenty-three in this, with varieties enough to delight a Darwinian.

Dr. Gray has omitted the Mosses, Lichens, Fungi, and Algæ, and very properly, for they are specialties in botanical science. We hope that some day the long hoped for supplementary volume may appear, in which all these orders shall be treated with equal thoroughness and accuracy, as the Mosses have been by Sullivant. Tuckerman and Curtis have all the material for their respective orders.

The plates of the Sedges are new to this volume, and have all the finish and nicety of Sprague's drawings. The young botanists of this country are favored in having for the writer of their manual one of the great masters of their science. When our hand-books are written with the same learning and breadth of treatment which are given to the most abstruse and recondite works of science, there is certainly unusual incentive and unwonted means for effort and advancement at our disposal.—C. J. S.

NATURAL HISTORY MISCELLANY.

ZOÖLOGY.

Common Objects of the Country.—From our extensive piazza, the number and variety of birds that we daily behold are to me so

marvellous, that, at the very least, I cannot forbear giving you a bit of "gossip" about them. As I have before stated, we live in the country, and are therefore supposed, by the pitying denizens of brick and stone, to be rather destitute of resources, and having no immediate neighbors, to be very dull and lonely, — but such is not possible where so many birds, insects, and creeping things abound, that the very air seems instinct with life and motion.

Sitting upon the piazza at this moment, I am not without companions, for the Mud-wasps are building upon the window ledges, the little brown Wren is in the box beneath the eaves (having first ejected the Blue-bird and its eggs), and the Carpenter-bee has accumulated quite a heap of sawdust from the railing, which is bored in more places than one by her long galleries and passages. I can also see in the gravelled walk the ridges thrown up by the Mole, of which the common and star-nosed varieties have been captured here, and can detect in the grass the perforations of another animal of the rat or mouse kind, a sight of which has thus far been denied us, as our old dog seems to think them too appetizing to exhibit before they are devoured. We only know they are plentiful, and their depredations annoying. The dogs were less particular with a muskrat which came to an untimely end through their means last season; when also a plump young woodchuck, captured by the mowers, and which they were endeavoring to place in confinement, fell a prey to their murderous propensities.

What place can be devoid of excitement where turtles are discovered feasting in the strawberry bed, and where, in the sleeve of a cast-off garment hanging in the bathing-house, we once found the nest of a field-mouse, and with breathless delight watched the frightened mother, with her large deer-like eyes and graceful motions, as she crept timidly to the spot, and one by one removed her young to a place of safety?

What revery can be lonely which is liable to be broken off by the plaintive cry of the fish-hawks, wheeling and circling about their nest, which is reared upon the summit of a blasted pine, not thirty rods from the house, and who may be descried passing overhead at any hour of the day, with some inmate of the deep depending from their talons?

We are also visited by another huge bird, a pair of which sit motionless, through the summer afternoons, upon the edge of the salt-marsh, and are known among the country people by the euphonious title of Quawks. The only ornithological description at all agreeing with them is that of the Qua-bird or *Night*-heron; and yet we certainly see them as early as three in the afternoon. In the same vicinity

we occasionally see a blue crane, and another larger bird of the heron species, describing that peculiar motion attributed by negro minstrelsy to Nelly Bly, —

"When she walks she lifts her foot,
And then she puts it down,"

and verily, they treat their long red legs as something to be careful of, to be deposited gingerly upon the mud, and lifted again with due deliberation. In strong contrast is the motion of the sandpiper, two or three varieties of which are always to be found gliding so quickly over the rocks, that whether they run or fly is almost a problem. In one of our drives we once captured an infant piper, and I have seen few things more comical than that minute downy ball, adorned with bill and legs, seemingly out of all proportion. Not having always lived on the sea-shore, the foregoing birds are comparatively new to me, but I do not mean to neglect the more familiar ones who haunt the trees and bushes directly about the house, — the chipping sparrow who seeks his daily meal of crumbs upon the piazza, sometimes joined by the cat-bird, — the robin, oriole, and the cuckoo, — the pewee, martin, and swallow, who all have nests within our precincts, — the noisy bobolink, and in the season of cherries, which are abundant here, a countless crowd of chatterers which it would be needless to enumerate.

I saw this spring one bird which I had never before seen, — the American Redstart, — which remained poised for a moment upon the piazza rail, so that we had a fair view of it. The ferruginous thrush, which seems quite as tame here as the robin, is almost new to me.

As the season advances, the golden-winged woodpecker and quail give themselves airs among the flower-beds on the lawn, so confident are they of not being molested; but at present we are interested in a family of owls who have frequented our trees for the last fortnight, and whose species I am unable to decide, unless it be the mottled owl. There are six in the family: the two whom we suppose to be the parents, rather object to being looked at, so that I have only had a good view of one, of which the following is a description, — back and wings of a sandy-red, with a white marking on the front of the wing similar to that on the wax-wing or cedar-bird; ears prominent, breast greyish speckled, and face ditto, with two dark lines extending from the base of the ears to the bill and enclosing the eyes. The four young ones, who generally sit side by side, and stare at us as long as we choose to stare at them, are all over of a silvery-grey, with less prominent ears. None of the company appear to be over seven inches high, and seem to haunt certain trees, where we can generally find them at any hour of the day, and they begin to be lively before sun-

set, often alighting upon the fence or the ground. We first discovered them by their peculiar hissing, like the spitting of a cat: the only other sound we have heard them emit is a faint "hoo-hoo," though while these six were in sight, we have heard the cry of the ordinary screech-owl in a grove at some distance.

Thus much for the owls, but when tired of Ornithology, we can resort to the insects, some of whom return the compliment by resorting to us; for we frequently find, in damp weather, a spider's web extending across the door (one in constant use), or from the inkstand to the ceiling.

The first week in May I found lying upon the ground a large chrysalis, which was at once placed with some earth in a vacant flower-pot, and on the first of July its inhabitant appeared, and proved a stranger to us; a large yellow moth with brown markings, and looking as if peppered with minute brown dots. After a close study of Harris's Insects, we made it out to be the imperial moth, *Dryocampa imperialis*. The specimen is a female, and has been condemned for the future to contemplate surrounding objects from the head of a large pin, in company with various others of its tribe.

And when we weary of insects, there are the reptiles, toads, snakes, and turtles; the latter all sizes and kinds,—huge snapping-turtles who inhabit a small pond, the shores of which furnish a home to the crested king-fisher, as well as the fish-hawk; ugly yellow land-turtles, and brook-turtles, in small compact boxes. I have witnessed on our own door-stone the phenomenon familiar to all naturalists, of a snake swallowing a toad, though in this instance he was not allowed to finish his meal in safety; but I have failed, in spite of all my efforts, thus far, to hear the song of the toad.

Finally, when reptiles fail, there is the beach with its shells and other waifs of interest, to say nothing of crabs, eels, and porpoises; but what is a greater marvel to me than all the rest is, that such a wealth of animal life should exist unmolested within twenty miles of New York city, and in such a populous resort, that one may turn from the contemplation of Nature to that of Fashion or Art in all their splendor and perfection,—fish-hawks one moment, and flounces the next,—water-fowl and water-falls in conjunction,—but—lest you should think I mean to rival the spider who spun from the inkstand to the ceiling, I will break my thread at once.—C. Pierrepont, *Wry Nose, N. Y.*

The Tiger-beetle.—The *Cicindela* represents among insects the character of the Tiger. Its large, powerful head, with its enormous scissor-like jaws, its light body, of elegant form and gay colors, together with its ferocious habits, prove its right to the name. The

number of species is very great, and they have been carefully studied, as they have ever been the favorites of entomologists.

They are usually of some shade of green, with metallic and purplish reflections, and marked with light-colored dots and short curved lines. The Tiger-beetle abounds in sunny paths, and breeds on the sandy shores of rivers, ponds, and the ocean, over which they swiftly fly, and run in chase of their prey. The larva (Fig. 1) is hideous in aspect. It has an enormous head, with immense jaws armed with teeth on the inside, while a large swelling on the ninth segment of the curved body, which ends in a horny, movable hook, gives it a grotesque and ugly appearance. This hook aids it in climbing up its deep hole, near the entrance of which it lies in wait for weaker insects. These holes are sunk perpendicularly in the sand, and have no waste dirt about the mouth, like ant or worm holes. Their occupants may be either

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

dug out, or on thrusting in a straw, will fiercely seize the intruding object with their hooked jaws, and, in the blindness of their rage, suffer themselves to be drawn out from their retreat.

While all our native species are ground beetles, there are others in the tropics which live, in the beetle state, on trees. Among our more common forms are the *Cicindela generosa* Dejean (Fig. 2), the largest of our New England species. The most common form is the *Cicindela vulgaris* of Say (Fig. 3). One of our most beautiful species is the *C. purpurea* of Olivier (Fig. 4), found flying about sunny walks; while the hairy-necked Tiger-beetle (*C. hirticollis* Say, Fig. 5), is a smaller species than the foregoing. Our most beautiful form is the six-spotted Tiger-beetle (*C. sex-guttata* Fabricius, Fig. 6), which is of a bright green color, ornamented with six spots on the wing-covers (*elytra*). It is often found in shady places not frequented by other

Fig. 6.

Fig. 7.

species. A much smaller species is the *Cicindela punctulata* Olivier (Fig. 7), which is dark bronze, and spotted on the elytra with white dots, in place of the more usual white dots and curved lines or lunules.

GEOLOGY.

THE CRINOIDAL BANKS OF CRAWFORDSVILLE, INDIANA.—Montgomery County, of which Crawfordsville is the county seat, belongs to the Sub-carboniferous formation, being just north of the northern out-crop of the Indiana and Illinois coal-fields. A large part of the country is covered with heavy drift. Rocks in place, however, crop out abundantly along Rock (Sugar Creek on some maps) River and its tributaries. These rocks are rich in fossils characteristic of the Sub-carboniferous strata: varieties of Productus, Spirifer, Terebratula, Conularia, etc.

But the fossils which have excited the most interest, and which have rendered this locality specially noted, are the beautiful Crinoidea. Along the banks of this river are strata of limestone, made up almost entirely of the broken stems and arms of Crinoids, cemented by carbonate of lime, and occasionally containing heads finely preserved.

But the geological horizon in which the heads of Crinoids are mostly found, is a calcareous shale or sandstone, of quite limited vertical extent, not much exceeding two feet in thickness, and often but six or eight inches. In this the Crinoids are abundant, and in great perfection, the arms and basal plates being well preserved, with stems attached, and not unfrequently even the finest tentacula. They are mostly of the following types: Actinocrinus, Cyathocrinus, Agaricocrinus, Platycrinus, Forbesiocrinus, Scapiocrinus, Zeacrinus, and Pentremites. These Crinoid beds have been wrought by some of the citizens of Crawfordsville for fifteen or twenty years, prominent among whom, as most persevering and entitled to the greatest credit, both for exploring and working out specimens, is Mr. O. W. Corey. He has furnished beautiful specimens to the Smithsonian Institution, Harvard University, Yale College, Michigan University, Wabash College, and also to many private cabinets. These beds have been explored also by the students and professors of Wabash College, who have enriched her cabinet with choice specimens. The College secured, by purchase of Mr. Corey, several hundreds of perfect heads, finely wrought out, fit for the cabinet. The bank nearest to Crawfordsville is the most productive, but the same strata are found cropping out at Island Ford, on Offil's Creek, on Walnut Fork, on Black Creek, as well as at several other points on Rock River.

The most extensive excavations have been made by Mr. Charles

Dyer, of Cincinnati, an enthusiastic collector of Western fossils, some years since, and quite recently by Mr. Frank H. Bradley, of New Haven, a successful collector of specimens of Natural History. This bank is situated half a mile north of the city, in a bluff seventy-five feet above the bed of the river. The out-cropping has been so far explored, that deep and heavy excavations are requisite to reach the Crinoidal horizon.

Crinoids or Encrinites are radiates belonging to the class of Echinoderms, found chiefly fossil and extinct, there being but two living species, the Comatula and Pentacrinus Caput Medusæ. They are so named from their resemblance in form to the lily. They are among the most beautiful and wonderful fossils we have.

The Encrinite consists of a calcareous root, a hollow jointed stem, a vasiform, or cup-shaped base upon its top, from which proceed arms with subdivisions; upon some of the arms are found very fine tentacula. Besides the fixed Crinoids, there are others which were free, and some imbedded in mud.

Crinoids exist most abundantly in the oldest fossiliferous rocks, belonging to the Palæozoic and Mesozoic periods; so abundant are they in some localities in the Palæozoic localities, as to give character to the rocks, as Crinoidal or Encrinital limestone. They are found among the earliest of fossil animals. For a long time their animal origin was disputed, till established by Rosinus, in 1719.

A large proportion of the genera described belong to the Silurian formation. The Palæozoic species amount to about five hundred, and those in the rocks above to nearly one hundred.—E. O. Hovey, *Wabash College*.

MICROSCOPY.

The Surface Fauna of Mid-Ocean.—In the sixth volume of the "London Microscopical Journal," Major S. R. J. Owen describes several forms of towing nets for collecting microscopic forms at sea. By such nets the Polycystina, with their interesting allies the Acanthometra, and the Thalassicola, can be found:—

"I am persuaded that the genera Pulvinulina and Globigerina, of the family Colymbitæ of the Foraminifera, will be found on the surface of the ocean near home. Dr. Wallich found them in great numbers in the sediment forming the bed of the Atlantic. From seventy to ninety-eight per cent. of this deposit in the deep seas is often composed of these Rhizopods. These two genera, together with the Orbulina of Dr. Carpenter, but which I have now proved to be a sub-genus of Globigerina, have been found to be surface-forms on every part of the ocean that I have sailed over. Different classes of creatures will be found on the surface during the night to those found in the daytime: from sunset till daylight the Polycystina, Foraminifera, Acanthometra, Entomostraca, Small Pteropods, and Shelled Mollusca must be looked for; during the day the Crustaceans, Thalassicola, Creseis, etc., will repay our endeavors."

ANSWERS TO CORRESPONDENTS.

B. W. S., Ky. — Fifteen volumes of the Proceedings of the American Association for the Advancement of Science have been published: they may be obtained of the Perpetual Secretary, Prof. J. Lovering, Cambridge, Mass.

G. W. B., Maine. — Among the most important works on Entozoa, or Intestinal Worms, are Cobbold's Entozoa, 4to, London, 1867. An Essay in Aitken's Practice of Medicine. An Essay on Human Cestoids, by F. R. Sturgis, 8vo, Cambridge, 1867. Human Cestoids, by Dr. D. F. Weinland, 8vo, 75 cents; a few copies of this last work may be had at this office. The best descriptive work is Diesing's *Systema Helminthum*, 2 vols. 8vo, published in Germany. See also Owen's article Entozoa, in Todd's Cyclopædia of Anatomy and Physiology.

J. F., New York. — Many instances of snakes charming birds and other animals have been recorded, but their power to do so is still doubted by many of the best authorities.

C. G. S., Penn. — Your so-called "horse hair" is a low parasitic hair-like worm, *Gordius*, which lives in the young or larval state in the bodies of grasshoppers, etc.; but when it becomes mature, crawls out of the body of its host, and lives in the mud at the bottoms of ponds and in moist earth.

EXCHANGES.

Andrew J. Bennett, Circleville, Ohio. — Would like to exchange Western land and fresh-water shells, for New England land and fresh-water shells.

E. P. Austin, Nautical Almanac Office, Washington, D. C. — Would like to exchange U. S. Coleoptera.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

American Association for the Advancement of Science. — Natural History Section. *Burlington, Vt., August* 21–26, 1867. —"Traces of Ancient Glaciers in the White Mountains of New Hampshire, with a few Remarks upon the Geological Structure of some Portions of that Group," by George L. Vose, of Paris, Me. This was a detailed account of the observations of Mr. Vose in the Androscoggin, Peabody, and other valleys of the region, confirming the view

that these valleys have been occupied by local glaciers as well as by a general one. Mr. Vose gave an account of his observations on the geological arrangement of the rocks forming the principal range, upon which he founded hypotheses as to the early condition of that region.

"On the Origin of the so-called Lignilites or Epsomites," by Professor O. C. Marsh, of Yale College. In limestone rocks, of all geological ages, there are frequently found columnar markings, and detached columns of the rock occurring along the seam between two beds of the same. Professor Marsh gave a notice of the different publications on the subject, showing what a puzzle they have long been to geologists. He exhibited a series of fine specimens, showing that they were due to pressure. Professor Marsh has been the first to show that the form of many perfect columns is due to the presence of a fossil shell or some foreign substance.

"On the Geographical Distribution of the Sediments and the Fossils in the Hamilton, Portage, and Chemung Groups of New York," by Professor James Hall. The object of the paper was to show that identity of fossil species must not be expected in rocks of the same geological age over wide geographical areas.

"Upon some remarkable Fossil Fishes obtained by Rev. H. Herzer from the Devonian Rocks at Delaware, Ohio," by Professor J. S. Newberry. Professor Newberry exhibited some splendid specimens of these fish remains, which Mr. Herzer obtained from concretions in the rock. The remains belonged to a genus of ganoid fishes, now made known for the first time. The fish must have been one of the monsters of the waters of those times, and very formidable. The head could not have been less than three feet long by two feet broad. On account of the great size, he had named it Dinicthys.

"The Fossil Insects of North America," by S. H. Scudder. This paper was a review of the entire subject, noticing eighty species of fossil insects, known in the strata of this continent. The oldest preserved remains of insects now known are from the Devonian rocks of New Brunswick, and furnish evidence that insects were introduced about the time that land-plants first appeared.

"Depression of the Sea during the Glacial Period." By Col. Charles Whittlesey. The existence of an ice epoch, during which the northern hemisphere above about latitude 40° was enveloped in ice *neve* and snow, being now generally admitted, I propose to notice the effects which would necessarily follow in depressing the surface of the ocean.

It is universally admitted that there have been in North America

changes of level, either of the land or the sea, or both, during the ice period, particularly towards its close.

I wish to consider principally the changes of sea-level resulting from the accumulation of continental ice. Such accumulations can only occur by depositions of moisture from the clouds, derived from the ocean by evaporation. The water-line, or surface of the sea, is constant, only because there is an equilibrium between evaporation and the water returned through the rivers. If depositions, in the form of rain, dew, and snow, remain perpetually congealed, they are not returned to the common reservoir, and to that extent its surface must settle away. If the limits of perpetual snow and ice should now be enlarged, these effects should follow. A decrease of temperature of *one degree* annually would lower the snow line about three hundred feet per annum, and increase the area of snow *neve* and ice, while evaporation would measurably cease; but over which deposition would continue.

The area supposed to have been covered by the ice mantle in North America, Northern Asia, and Europe, is equal to about *one-fifth* of the northern hemisphere. The ice-field must also have encroached upon the bays, fiords, sounds, lakes, and minor sea spaces adjacent, which with the enlargement of the South Pole Continent, I assume to be as much more, or equal to *one-fifth* of the surface of the globe. The evaporating surface of the ocean became restricted, as the congealed surface of the land and the sea enlarged, and the ocean mass became diminished.

In reference to dry land, the present ocean is determined to be as three to one; the earth presenting a surface three-fourths water and one-fourth land. Geographers estimate the water surface at 111,000,000 of square miles, the land at 37,000,000. If both the extent and the thickness of the ice covering could be determined, its mass would be easily fixed, and also the increase or diminution it would cause in the waters of the sea.

Dr. Hayes penetrated seventy miles from the sea at Port Foulke, Greenland, over the continental ice, which attained an elevation of 5,000 feet. The ice-grooving in New England reaches a height varying from 4,300 to 5,300 feet above the present level of the sea. Ice etchings extend from beneath the waters of Lake Superior to the tops of the highest mountains, 1,000 to 1,200 feet above its surface. The ice coating may have been 1,500 to 2,000 feet thick over much of the central part of British America. Its bulk is about one-tenth greater than water, and, dissolved on the same space, would fill a height of nine-tenths, or ninety feet in a hundred.

If it attained an average thickness of 2,000 feet in a solid state, it

would, in a liquid form, rise to 1,800 feet on the same area. If one-fifth of the earth was enveloped in congealed water, and four-fifths of its surface was free, the transfer of the liquid portion from the sea to the land, where it should remain, would depress the sea one-fifth of the vertical distance above assumed, for the water produced by the melting ice.

Dynamical results may have followed the accumulation of continental ice. The continent of Greenland is considered to be settling at a perceptible rate, — of necessity a sinking of one part of the earth's surface involves a rise in another, and generally an adjacent part, — accordingly the island of Newfoundland is reported to be rising. Professor Hall and other geologists claim that accumulations of detritus may reach a point where, by weight alone, depression must follow. If this theory is tenable, a load of ice would produce like results.

I present this idea for the consideration of geologists, when they study the phenomena of the fresh-water drift and terraces of the Great Lakes, which now stand on a level with the marine drift beds of Lake Champlain and the St. Lawrence. In the interior, over vast spaces extending to the Rocky Mountains, north and west of the lakes, there are no known elevations exceeding 2,000 feet above tide. A sinking seems to have taken place over this region, while the seacoast as far as the east end of Lake Ontario was rising, the axis or line of rest being near the middle of this lake, and its bearing nearly across it.

California Academy of Natural Sciences. *San Francisco, July* 1, 1867. — The eggs, caterpillar, female and cocoon, of the California silk-worm (*Saturnia Californica*, or *Eryalus* of Boisduval), were presented by Dr. Lanszweert, who remarked that the number of eggs of this silk-worm is from two hundred to two hundred and fifty. The female lays, on an average, from seventy to eighty per day. Three thousand eggs weigh an ounce. The caterpillar, direct from the egg, is more lively than that of the Chinese silk-worm, and hardly keeps in its place. The silk produced by this worm is stronger than that of the Chinese, and is indigenous to California. Living on the *Ceanothus*, it is well worth the attention of our silk-growers, as perhaps in feeding it on the mulberry a finer quality of silk would be obtained. The eggs were obtained from a female caught in the garden of the Philadelphia Brewery, Second street, in this city, on the 10th of June. The eggs were hatched on the 30th of the same month. The caterpillar requires generally from two to two and a half months before making its cocoon.

Mr. Stearns exhibited specimens of *Haliotis* from Monterey, which he had received from Dr. Canfield, of that place. The peculiarity of the specimens consisted in their being *hybrids*—a cross between the two species known to conchologists as *H. Cracherodii* and *H. rufescens*. In this connection Mr. S. made some general remarks upon the *Haliotidæ*. Dr. Cooper followed Mr. Stearns, and remarked upon the geographical distribution of this genus of mollusca.

A paper was read by Dr. W. P. Gibbons, of Alameda, in which he resumed the subject of the extinct forest of redwood on the Coast Range, near San Antonio. He directed attention to the fact that some of those stumps indicated a method of growth different from ordinary forest trees. Their immense size was due, in some cases, to the fact that three or four trees, growing in proximity, would ultimately impinge on each other, and if supplied with sufficient nourishment, they would grow together and form one immense trunk. This theory was verified by the statements of Dr. Kellogg and Mr. Bolander, who mentioned the fact that near Searsville several redwood trunks had grown together, and for forty feet formed a solid tree. There is no dependence in estimating the age of such trees in any other way than by carefully counting the number of concentric growths from a centre. The oldest of these redwoods is about 1,500 years of age. The *gigantea* of Calaveras is about the same age. These redwoods are evidently the second generation of the race; hence we may infer that 3,000 years, at least, have passed by since the present growth first commenced on the Coast Range. But long before this must vegetation have covered portions of these hills, as the *Sequoia* reposes in a bed of alluvium twenty or thirty feet in depth. He also referred to the bulbous expansion of these trees near the base. These are composed of large expanding roots, growing together, and forming a complete network. The height of this indicates the degree of denudation which the soil has undergone during the lifetime of the tree. This is about five feet in 1,500 years. Some of these trunks have from 10,000 to 14,000 buds, partially developed, around their base, each bud having the power, under favorable conditions, of being developed and containing a perfect tree. The mass of wood contained in a tree twenty-five feet in diameter is equal to 40,000 cubic feet, weighing over 2,500,000 pounds.

BOOKS RECEIVED.

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Epitome of Elocution. By B. W. Atwell. Providence, 1867. 12mo.

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